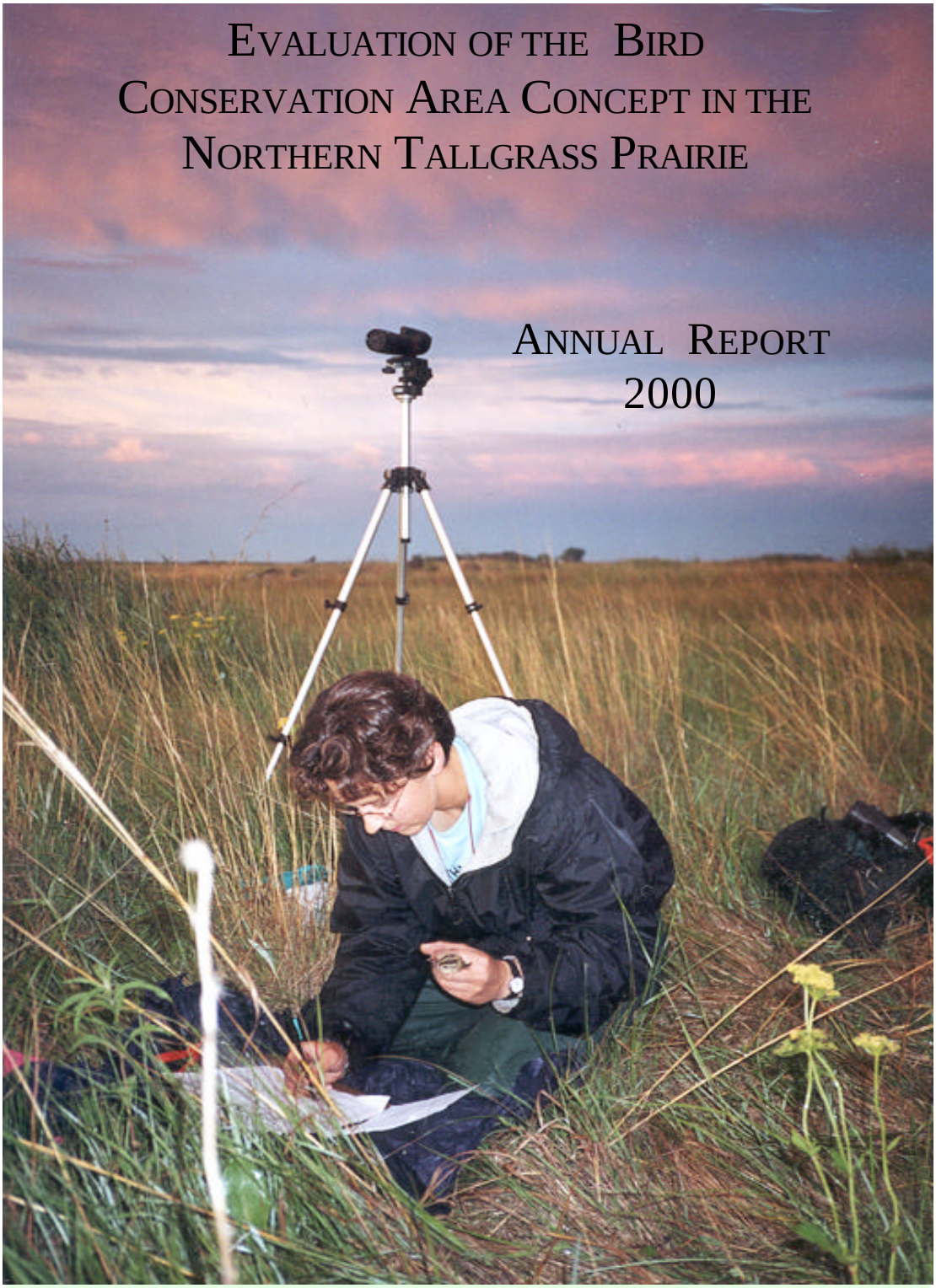
Evaluation of the Bird Conservation Area Concept in the Northern Tallgrass Prairie

Annual Report 2000



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EVALUATION OF THE BIRD CONSERVATION AREA CONCEPT IN THE NORTHERN TALLGRASS PRAIRIE

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Cover Photo: Colleen LeFevre recording measurements on a mist-netted Savannah Sparrow
Cover Photo taken by: Maiken Winter

Executive summary

In 1998 we initiated a test of the concept that Bird Conservation Areas (BCA's) can maintain populations of breeding grassland birds. The underlying hypothesis is that large core areas of quality habitat (such as native prairie) that are surrounded by neutral habitats (such as small-grain fields), and that are isolated from hostile habitats (such as woody vegetation) will result in avian densities and reproductive rates sufficient to at least maintain population levels of breeding birds. This concept was proposed by the Midwest Working Group of Partners In Flight (e.g., Pashley and Fitzgerald 1996) and endorsed also by the Prairie Pothole Joint Venture of the North American Waterfowl Management Plan. This evaluation is being conducted in the northern tallgrass prairie, but the concept may be more generally applicable.

In 1999, we added 11 study plots in Sheyenne National Grassland in southeastern North Dakota to the existing 33 study plots in northwestern Minnesota. All study plots were assigned to one of four categories: 1) small core area surrounded by neutral landscape, 2) small core area surrounded by hostile landscape, 3) large core area surrounded by neutral landscape, and 4) large core area surrounded by hostile landscape. On each of the 44 study plots we collected data on population density of breeding birds by censusing each plot twice during the field season. Data on nesting success, predation, and brood parasitism were obtained from a subset of 29 study plots. In addition, we color-banded birds on four of the study plots, focusing on Clay-colored Sparrow, Savannah Sparrow and Bobolink. In 2000, we recorded 54 species on our census plots (compared to 41 and 53 in 1998 and 1999, respectively), found 679 nests of 39 species (compared to 293 of 19 species, and 793 of 34 species in 1998 and 1999), and color-banded 334 birds (compared to 263 in 1999).

Background and Justification

Grasslands are recognized by many as the most imperiled ecosystem worldwide (Samson and Knopf 1994, Noss et al. 1995). The avian assemblages associated with grasslands also are at risk - grassland bird populations have shown steeper, more consistent, and more geographically widespread declines than any other guild of North American species (Department of the Interior 1996). Breeding Bird Survey data from 1966-1993 indicate that almost 70 percent of 29 grassland bird species adequately

surveyed by BBS data had negative population trends; more than half of these was statistically significant.

In addition to range-wide population declines, the distribution and abundance of many grassland species are highly variable in space and time (Igl and Johnson 1999), which complicates conservation plans for grassland bird species. At both local and range-wide scales, variation in numbers from year to year may be driven by (1) climate patterns, which may significantly alter vegetation characteristics of the site and hence habitat cues used by birds in selecting breeding territories (Igl and Johnson 1999, Price 1995); (2) changes in the habitat caused by management actions or natural disturbances; (3) success of birds in raising young at that location in previous years, which may influence return rates and hence population stability at a site; or (4) changes in landscape structure caused by agriculture, urban sprawl, or other human activities. The relative importance of each of these factors has not been well established for grassland species, yet such knowledge is crucial to understanding patterns of range-wide population declines and local-scale fluctuations in grassland bird populations.

In an attempt to reverse population declines of grassland birds, the management concept of Bird Conservation Areas (BCA's) was suggested as a means to conserve grassland songbird populations (Pashley and Fitzgerald 1996). The notion behind BCA's is that core areas of quality habitat (such as native prairies) that are isolated from hostile habitats (such as woody vegetation) will result in reproductive rates sufficient to maintain population levels of breeding birds (Henderson and Sample 1995). The BCA concept implies that the value of high-quality core areas depends on the habitat composition of the landscape matrix in which the core areas are embedded. This concept is being promoted despite the absence of data that validate its usefulness in maintaining viable populations of grassland songbirds.

Moreover, the U.S. Department of the Interior (DOI) Conservation Strategy for declining birds in grassland ecosystems (DOI 1996) calls for information on the effects of habitat and landscape features on population viability of grassland birds. High-priority information needs identified by the DOI include effects of habitat structure and composition on avian communities and effects of landscape context (e.g., patch distribution, surrounding land use, and proximity to hostile environments) on avian numbers and nesting success. Furthermore, factors associated with highly variable population numbers (climate, habitat changes, nesting success) are needed to determine

causes of population stability or instability over time. This information is critical for developing long-term conservation objectives that will benefit grassland birds, but is lacking for many grassland bird species.

The BCA concept was proposed by the Midwest Working Group of Partners In Flight and supported also by the Prairie Pothole Joint Venture. It was included in the draft of the Landbird Conservation Plan for Physiographic Area 40: the Northern Tallgrass Prairie. This evaluation of the BCA concept in the northern tallgrass prairie is intended to determine whether BCA's do, in fact, meet their intended objectives. The effort addresses needs identified in the Landbird Conservation Plan by evaluating its assumptions.

For this evaluation, we are considering native prairie (parts of which may have been restored) to be high quality habitat; heavily wooded vegetation, which can harbor high numbers of predators and brood parasites, to constitute hostile habitat; and small-grain and hayfields to be neutral habitats.

Objectives

1. To estimate distribution, abundance, and reproductive success of grassland bird species in large and small core habitats embedded within hostile and neutral landscape matrices.

2. To estimate between-year site fidelity of grassland songbirds and factors that influence site fidelity.

Study Areas

In 2000 the study was conducted in three areas in the northern tallgrass prairie: (1) east of Moorhead, MN, in Becker, Mahnomen, and Clay counties; (2) east of Crookston, MN, in Polk County; and (3) in southeastern North Dakota at the Sheyenne National Grassland in Richland and Ransom counties. Study sites include tracts owned by the U.S. Fish and Wildlife Service, U.S. Forest Service, Minnesota Department of Natural Resources, and The Nature Conservancy (Table 1).

Methods

Study Design.--We are using a two-way factorial experimental design to address three major questions: (1) Does size of core habitat patch influence density and nesting success of birds? (2) Does landscape matrix (extent of woody vegetation surrounding the core habitat) influence density and nesting success of birds? and (3) Do patch size and landscape matrix show interactive effects? Main effects in the design are habitat size and landscape matrix, with several replicate plots within each size*landscape combination. All study plots were within native or restored prairie of similar vegetation structure and composition and varied between 1.0 and 16 ha in size.

In total, 21 study plots were established within core areas that are "small" in size (<50 ha), and 23 study plots were established within core areas that are "large" in size (>250 ha). We searched for nests in 15 study plots within small core areas and in 13 study plots within large core areas. Differences in abundance and reproductive measures between large and small core areas will be referred to as "main effects of size." Twenty-one study plots (11 in small core areas and 10 in large core areas) were established within hostile landscapes. Hostile landscapes include landscapes that contain large areas of woodland habitat within 5 km of the core habitat. Twenty-three study plots (10 in small core areas and 13 in large core areas) were established within neutral landscapes. Neutral landscapes include landscapes that consist of habitats that are thought to have little or no negative impact on bird populations within the core areas, such as small-grain fields, hay-meadows, or Conservation Reserve Program fields. Differences in abundance and reproductive measures between hostile and neutral landscapes will be referred to as "main effects of landscape composition." Interactive effects between core habitat size and landscape matrix also will be examined.

Field methods.--On all 44 study plots, we measured vegetation characteristics and bird abundance. Nesting success was investigated on a subset of 29 of the study plots (Table 1). Study plots were marked with flags or wooden laths at 50-m intervals along transects that were 100 m apart. Vegetation was assessed at 10 to 34 measuring points within each study plot, systematically located throughout each plot. The number of measuring points taken within a plot varied with the size of the study plot. Vegetation was measured once, in early to mid July. Measurements included vegetation height, percentage cover by

growth form (grass, forb, woody, bare ground, litter, and standing residual) based on a 20x50 cm Daubenmire frame, height-density (Robel readings), number of small ($\leq$ 30 cm tall) and large (>30 cm tall) woody stems, and litter depth. Vegetation characteristics in each study plot were evaluated to determine the associations between habitat characteristics, local (patch size) features, landscape features, and density of each species.

Abundance of breeding birds of all species was determined on each study plot by strip-transect censuses (Stewart and Kantrud 1972). Censuses were conducted twice between 22 May and 24 June. The maximum count of a species was used to determine density (number of males/100 ha).

We assessed reproductive success of birds by searching for nests and monitoring eggs and young until fledging. The observers located nests by walking through fields with or without flushing-sticks and looking for nests after flushing or observing birds. Nests were marked with a flag 5 m to the north and were revisited every 3 days to ascertain its status and the incidence of brood parasitism. Nest success was determined using the Mayfield method (Mayfield 1961). A nest was considered successful if it fledged at least one young of the parental species, and it was considered parasitized if it contained at least one Brown-headed Cowbird egg or chick. We focused our nest searching efforts on three species: Savannah Sparrow, Clay-colored Sparrow, and Bobolink.

Nest vegetation was characterized within one week after activity at a nest had ceased. Vegetation was measured at five sites near each nest: directly at the nest and at a distance of 0.5 m from the nest in each cardinal direction. At each of the five points we measured vegetation in the same manner as described above for plot vegetation. Vegetation characteristics at the nest were evaluated to determine the associations between reproductive success by species and microhabitat (vegetation), local (patch size), and landscape features.

Four of the 44 study plots (two plots in large core areas surrounded by neutral landscape, and two plots in small core areas surrounded by hostile landscape) were designated as intensive sampling plots. On these we captured and marked birds to assess factors associated with population stability at a local site over time, again focusing on Savannah Sparrows, Clay-colored Sparrows, and Bobolinks. Birds were banded with an aluminum federal band and a combination of three color-bands. In 1999 and 2000, the four sites were monitored throughout the season to determine the number and identity of

individuals that returned from previous nesting seasons. Unbanded birds nesting on the plot were then targeted for banding. We then focused on monitoring banded birds to determine their season-long fecundity and movements within a plot. The goal of the intensive-sampling plots is to evaluate the number of young fledged per year and site fidelity for each adult of the three focal species. Site fidelity was measured in terms of returning to a site between years.

In 2000 we added one more aspect to our study: we employed miniature video cameras (Pietz and Granfors 2000) at nest sites of the three focal species to determine the types of nest predators that affect nests in our study area. Cameras were employed within and close to study sites in the Crookston area at nests of Savannah Sparrows, Clay-colored Sparrows, and Bobolinks.

Results

We recorded 54 species of birds on our study sites in 2000 (Table 2). The four most common species were Savannah Sparrow, Bobolink, Le Conte's Sparrow, and Clay-colored Sparrow. Le Conte's Sparrows and Savannah Sparrows generally occurred in each patch size in relatively high densities. However, Le Conte's Sparrows appeared to have higher densities in large plots within neutral landscapes, whereas Savannah Sparrows seemed to be affected primarily by landscape structure. In contrast to the Savannah Sparrow, Clay-colored Sparrows preferred hostile to neutral landscapes, also independent of patch size. Bobolinks seemed to prefer either large prairie patches or patches situated in neutral landscapes. The only grassland-nesting species that was restricted to large plots was the Greater Prairie-Chicken. Short-eared Owls were found only in plots in neutral landscapes.

Species composition differed slightly among the three regions (Table 2). Some species were detected in only one of the three regions, such as some duck species, Wilson's Phalarope, and Field Sparrow, which were found only at Sheyenne National Grassland. Further, species' densities varied among regions (Table 2); for example, Savannah and Le Conte's sparrows reached highest densities in the Crookston region, whereas Western Meadowlarks and Grasshopper Sparrows were recorded most frequently at Sheyenne National Grassland. Bobolinks and Clay-colored Sparrows had similar densities across the three regions.

We found 679 nests of 39 species (Table 3), compared to 1999 (where we found 793 nests of 34 species), and 1998 (where we found 295 nests of 19 species). The total number of nests found during the last three field seasons thus totals 1767. Most of the nests found belonged to the three focal species, Savannah Sparrow, Clay-colored Sparrow, and Bobolink (Table 3), so that the total number of nests belonging to one of the focal species is 1180. The most unusual nest we found this year was of a Dickcissel in the Glyndon area, a species that usually does not breed so far north.

Nesting success of the focal species was lowest for Bobolinks. For nests pooled over all plots, the Mayfield probability of daily nest survival was 0.937 for Savannah Sparrows, 0.923 for Clay-colored Sparrows, and 0.906 for Bobolinks. These translate to 21.8%, 28.1%, and 9.3% probabilities that a nest survives the incubation and nestling periods.

Nesting success varied greatly among regions, as did patterns in relation to patch size and landscape (Table 4). Contrary to last year's results, nesting success of both Savannah and Clay-colored sparrows did not seem to be affected by either patch size or landscape structure. Although patterns vary among regions, Bobolinks generally had higher nest success in large prairie patches surrounded by neutral landscape.

The main cause of nest failure was depredation (Table 5). Other causes of nest failure included 1) nest abandonment due to partial predation, cowbird parasitism, or unknown reasons, 2) cowbird predation (complete predation of nests by cowbirds occurred only at Sheyenne National Grassland), 3) trampling (mainly by cows), 4) weather related factors (mainly drowning in the nest), and 5) unknown causes.

Cowbird parasitism was low, with 6.4% (34/531) of all grassland passerine nests parasitized (Table 6). The most heavily parasitized species were Red-winged Blackbird, Western Meadowlark, Brewer's Blackbird, and Savannah Sparrow. All other grassland passerines had overall parasitism rates below 5%, even though in a single region parasitism rates were higher for some species.

We deployed cameras at 27 nests, 11 of which were depredated. Nest predators were of a wide array of species: thirteen-lined ground squirrel, short-tailed weasel, long-tailed weasel, American badger, red fox, striped skunk, Northern Harrier, American Kestrel, Brown-headed Cowbird, and one unidentified predator. In addition, a Plains garter snake caused one forced fledging. No single predator species prevailed for any bird species, or in any patch size/landscape configuration. On small neutral plots, 14

nests were videotaped; of those, five nests were depredated, by Brown-headed Cowbird, striped skunk, red fox, American badger, and an unidentified predator. On large neutral plots, cameras were employed at nine nests, of which three were depredated, two by short-tailed weasels and one by a thirteen-lined ground squirrel. On large hostile plots, cameras were employed at four nests, three of which were depredated, two by Northern Harriers and one by an American Kestrel. Due to limited accessibility, cameras were not set up on small hostile plots.

We color-banded 334 birds, 280 of which were focal species: 158 Savannah Sparrows, 92 Clay-colored Sparrows, and 30 Bobolinks. Twenty-nine of these banded birds had been banded in previous years: one female Le Conte's Sparrow (in 1999), 19 Savannah Sparrows (4 in 1998, and 15 in 1999, four Clay-colored Sparrows (1 in 1998, and 3 in 1999), and 5 Bobolinks (1 in 1998, and 4 in 1999). Four male Savannah Sparrows have been caught during each year of the study. We found 52 nests for which at least one of the two parents was banded (36 Savannah Sparrows, 11 Clay-colored Sparrows, 5 Bobolinks). Ten of these nests had both parents banded (6 Savannah Sparrow nests, 3 Clay-colored Sparrow nests, and 1 Bobolink nest). Contrary to 1999, we did not document any renesting or double-brooding in 2000.

Discussion and Future Plans

This study demonstrates the dynamic nature of grasslands and their avifauna. Not only do densities of breeding birds vary regionally and temporally, but so do interactions with their predators and brood parasites. This variability is reflected in the effects associated with habitat patch size and landscape features. After the third field season we have studied more than 1700 nests. As yet, however, it would be premature to conclude how grassland-nesting birds respond to patch size and landscape structure. The variation in avian density, nesting success, and their responses to explanatory variables demonstrates the importance of conducting studies over multiple years, as well as at multiple sites. Basing recommendations on the results of a single year of investigation could be unsound indeed.

In the fourth and final field season we will again census and nest-search the study sites in each of the three regions, color-band and resight birds on the four intensive study

plots in the Crookston region, and set up cameras at Savannah Sparrow and Clay-colored Sparrow nests to better determine the nest predators involved.

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Table 1. Study sites in northwestern Minnesota and southeastern North Dakota tallgrass prairie patches.

Prairie	Size category	Landscape	Plot size (ha)	Nest search?	Ownership
Crookston Region (Minnesota)					
Foxboro	small	neutral	6.00	Yes	SNA[1]
Mentor SW	small	neutral	9.00	Yes	WMA[2]
Shypoke	small	neutral	6.00	Yes	WMA
Dugdale	small	neutral	6.00	No	WMA
Chicog NW	small	hostile	3.75	Yes	WMA
Mentor W	small	hostile	8.75	Yes	WMA
Tilden	small	hostile	8.25	Yes	WMA
Mentor NW	small	hostile	3.00	No	WMA
Pankratz S	large	neutral	16.00	Yes	TNC[3]
Tympanuchus	large	neutral	16.00	Yes	WMA
Pankratz N	large	neutral	16.00	No	TNC
Pembina Trail	large	neutral	16.00	No	TNC
Burnham Creek	large	hostile	12.00	Yes	WMA
Pankratz/Kertzonville	large	hostile	15.00	Yes	TNC/WMA
Chicog W	large	hostile	12.00	No	WMA
Glyndon Region (Minnesota)					
Hoykens	small	neutral	5.75	Yes	WPA[4]
"Refuge"[5]	small	neutral	10.50	Yes	State Game Refuge
Spring Creek	small	neutral	12.00	Yes	WPA
Zimmerman	small	neutral	6.00	No	TNC
Eide	small	neutral	1.00	No	WPA
Sagebraaten	small	neutral	3.00	No	WPA
"Private"[6]	small	hostile	4.50	Yes	WPA
Ulen	small	hostile	5.50	Yes	WMA
Buffalo E	small	hostile	3.00	No	State Park
Bicentennial	large	neutral	16.00	Yes	SNA
Bluestem N	large	neutral	15.25	Yes	TNC
Margherita	large	neutral	12.00	No	TNC
Blazing Star	large	neutral	16.00	No	TNC
Rice-Elliott	large	neutral	16.00	No	TNC
Bluestem S	large	hostile	15.00	Yes	TNC
Buffalo W	large	hostile	16.00	Yes	State Park
Flickertail	large	hostile	12.00	No	WPA
Fuglie	large	hostile	16.00	No	WPA

Table 1 cont. Study sites in northwestern Minnesota and southeastern North Dakota tallgrass prairie patches.

Prairie	Size category	Landscape	Plot size (ha)	Nest search	Ownership
Sheyenne National Grassland (North Dakota)					
Shrike	small	hostile	2.75	Yes	USFS
Pileated	small	hostile	7.00	Yes	USFS
Camp	small	hostile	7.25	Yes	USFS
Surprise	small	hostile	1.50	No	USFS
North	large	neutral	16.00	Yes	USFS
Highway	large	neutral	16.00	Yes	USFS
Plum	large	neutral	16.00	Yes	USFS
Southeast	large	neutral	16.00	No	USFS
Savannah	large	hostile	16.00	Yes	USFS
Eagle Point	large	hostile	14.00	Yes	USFS
Hammock	large	hostile	16.00	No	USFS

[1] Scientific and Natural Area
[2] Wildlife Management Area
[3] The Nature Conservancy
[4] Waterfowl Production Area
[5] State Game Refuge on north side of Hwy 26 at large rock pile, east of Hwy 9.
[6] State Game Refuge immedia tely south of the Shrike Unit

Table 2. Mean bird density/100 ha (± standard error) in small and large plots in neutral and hostile landscapes, by region, in 2000. Species are in taxonomic order.

Species	Crookston				Glyndon				Sheyenne		
	Small		Large		Small		Large		Small	Large	
	Neutral N= 4	Hostile N=4	Neutral N= 4	Hostile N= 3	Neutral N= 6	Hostile N= 3	Neutral N= 5	Hostile N= 4	Hostile N= 4	Neutral N= 5	Hostile N= 2
Mallard	0	0	0	0	18.2 " 16.4	0	2.9 " 1.8	0	0	2.5 " 1.5	3.6 " 3.6
Green-winged Teal	0	0	0	0	0	0	0	0	0	2.5 " 2.5	0
Blue-winged Teal	0	0	0	0	0	0	0	0	0	8.7 " 5.4	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	1.2 " 1.2	3.6 " 3.6
Northern Pintail	0	0	0	0	0	0	0	0	0	1.2 " 1.2	0
Wood Duck	0	0	0	0	2.9 " 2.9	0	0	0	0	0	0
Sora	0	0	0	0	2.4 " 2.4	0	0	0	0	0	0
Marbled Godwit	4.2 " 4.2	0	1.6 " 1.6	0	0	0	4.2 " 1.7	0	0	5.0 " 2.3	0
Wilson's Phalarope	0	0	0	0	0	0	0	0	0	11.2 " 6.1	0
Killdeer	0	0	1.6 " 1.6	0	2.9 " 2.9	0	0	0	0	2.5 " 1.5	3.6 " 3.6
Common Snipe	6.9 " 4.2	6.7 " 6.7	7.8 " 1.6	2.2 " 2.2	2.9 " 2.9	0	1.2 " 1.2	0	0	1.2 " 1.2	14.0 " 0.2
Upland Sandpiper	2.8 " 2.8	0	3.1 " 1.8	2.2 " 2.2	0	0	2.5 " 1.5	0	0	1.2 " 1.2	6.9 " 6.9
Red-tailed Hawk	0	8.3 " 8.3	0	0	0	0	0	0	0	0	0
Northern Harrier	4.2 " 4.2	0	0	0	1.6 " 1.6	0	4.2 " 1.7	3.2 " 1.8	0	0	0
American Kestrel	0	0	0	0	0	0	1.2 " 1.2	1.6 " 1.6	0	0	0
Short-eared Owl	0	0	1.6 " 1.6	0	1.6 " 1.6	0	2.5 " 1.5	0	0	0	0
Greater Prairie-Chicken	0	0	9.4 " 7.4	0	0	0	2.9 " 1.8	0	0	1.2 " 1.2	3.4 " 3.4
Morning Dove	0	0	0	0	0	0	0	0	0	1.2 " 1.2	0
Northern Flicker	4.2 " 4.2	0	0	0	0	0	0	0	0	0	0
Eastern Kingbird	4.2 " 4.2	0	1.6 " 1.6	7.7 " 0.5	4.8 "4.8	18.5 " 9.8	2.6 " 1.6	3.6 " 2.1	19.6 " 7.9	3.7 " 2.5	10.6 " 3.7
Willow Flycatcher	0	2.9 " 2.9	0	0	0	0	0	0	0	0	0
Alder Flycatcher	0	0	0	0	0	0	1.3 " 1.3	0	0	0	0
Bank Swallow	0	0	0	0	0	0	0	7.8 " 7.8	0	0	0
Barn Swallow	0	3.0 " 3.0	1.6 " 1.6	0	2.0 " 2.0	6.1 " 6.1	3.8 " 1.6	2.1 " 2.1	18.2 " 18.2	12.5 " 6.6	3.6 " 3.6
Tree Swallow	0	0	0	0	5.3 " 3.4	28.3 " 19.9	18.7 " 10.5	4.7 " 4.7	0	0	10.3 " 10.3
American Crow	0	0	0	0	0	0	0	0	7.1 " 7.1	0	0
Marsh Wren	0	0	0	5.3 " 5.3	17.6 " 7.2	0	0	0	0	1.2 " 1.2	0
Sedge Wren	30.6 " 17.8	8.6 " 8.6	56.2 " 28.1	26.0 " 13.9	5.5 " 3.9	14.8 " 14.8	11.3 " 5.7	17.2 " 11.8	0	5.0 " 5.0	6.9 " 6.9
House Wren	0	0	0	0	0	11.1 " 11.1	0	2.1 " 2.1	0	0	0

Table 2 cont. Mean bird density/100 ha (± standard error) in small and large plots in neutral and hostile landscapes, by region, in 2000. Species are in taxonomic order.

Species	Crookston				Glyndon				Sheyenne		
	Small		Large		Small		Large		Small	Large	
	Neutral N= 4	Hostile N=4	Neutral N= 4	Hostile N= 3	Neutral N= 6	Hostile N= 3	Neutral N= 5	Hostile N= 4	Hostile N= 4	Neutral N= 5	Hostile N= 2
American Robin	0	0	0	0	0	0	0.6 " 0.6	0	0	0	0
Gray Catbird	0	0	0	2.2 " 2.2	0	0	1.3 " 1.3	1.6 " 1.6	0	0	3.6 " 3.6
Warbling Vireo	0	0	0	0	0	0	0	0	9.1 " 9.1	0	3.6 " 3.6
Yellow Warbler	0	0	0	5.6 " 5.6	5.3 " 3.4	17.2 " 9.6	7.8 " 5.3	2.1 " 2.1	0	0	3.6 " 3.6
Common Yellowthroat	8.3 " 4.8	6.7 " 6.7	7.8 " 4.7	9.9 " 1.7	26.5 " 9.4	13.5 " 6.8	16.7 " 7.7	18.8 " 9.8	6.9 " 6.9	2.5 " 2.5	10.7 " 10.7
Grasshopper Sparrow	0	15.1 " 15.1	3.1 " 1.8	0	11.1 " 11.1	0	37.2 " 15.8	0	48.9 " 30.2	67.5 " 21.4	59.7 " 4.6
Le Conte's Sparrow	55.6 " 26.1	65.9 " 31.8	107.8 " 29.1	79.4 " 39.9	19.5 " 8.6	52.5 " 27.2	76.4 " 24.4	19.5 " 7.1	0	31.2 " 8.8	24.7 " 11.0
Vesper Sparrow	0	0	0	2.7 " 2.7	0	0	0	0	17.7 " 13.5	0	3.6 " 3.6
Savannah Sparrow	162.5 " 34.9	73.5 " 10.5	173.4 " 5.3	86.8 " 11.0	91.1 " 25.8	46.5 " 23.3	104.0 " 36.8	34.2 " 12.0	0	101.2 " 18.0	63.8 " 36.2
Song Sparrow	0	0	0	0	12.9 " 6.8	17.2 " 9.6	1.3 " 1.3	13.7 " 5.2	0	0	3.6 " 3.6
Field Sparrow	0	0	0	0	0	0	0	0	10.5 " 6.6	0	0
Clay-colored Sparrow	20.8 " 8.0	52.9 " 10.5	34.4 " 14.5	58.3 " 32.8	53.9 " 15.9	76.1 " 6.6	38.5 " 17.3	76.2 " 27.8	87.1 " 30.6	10.0 " 8.5	46.3 " 39.4
Swamp Sparrow	8.3 " 8.3	0	0	0	10.8 " 5.5	0	0	0	0	0	0
Nelson's Sharp-tailed Sparrow	0	0	1.6 " 1.6	0	0	0	0	0	0	0	0
Bobolink male	22.2 " 15.7	3.0 " 3.0	51.6 " 6.4	27.4 " 3.0	73.0 " 14.6	39.1 " 21.2	40.6 " 3.4	26.0 " 14.8	47.1 " 31.5	60.0 " 23.2	10.2 " 1.2
Western Meadowlark	6.9 " 4.2	3.0 " 3.0	10.9 " 3.0	0	3.5 " 2.3	0	9.7 " 2.1	1.6 " 1.6	16.1 " 7.5	31.2 " 3.9	24.7 " 11.0
Red-winged Blackbird	15.3 " 6.9	0	10.9 " 5.3	5.3 " 5.3	81.3 " 20.1	0	16.2 " 9.6	0	0	41.2 " 18.1	53.1 " 25.5
Yellow-headed Blackbird	0	0	0	0	0	0	0	0	0	5.0 " 5.0	0
Brewer's Blackbird	12.5 " 12.5	0	3.1 " 3.1	0	0	0	0	0	0	0	0
Brown-headed Cowbird female	8.3 " 8.3	0	3.1 " 3.1	0	2.9 " 2.9	11.1 " 11.1	0	1.6 " 1.6	9.1 " 9.1	18.7 " 6.2	21.3 " 14.4
Brown-headed Cowbird male	5.6 " 5.6	0	4.7 " 4.7	2.2 " 2.2	6.9 " 3.2	11.1 " 11.1	8.2 " 3.3	3.3 " 3.3	9.1 " 9.1	22.5 " 6.1	21.3 " 14.4
Common Grackle	0	0	0	0	0	0	0	0	0	2.5 " 1.5	17.9 " 17.9
Northern Oriole	0	0	0	0	0	0	0	0	0	0	3.6 " 3.6
American Goldfinch	0	12.7 " 7.4	0	0	9.5 " 5.4	29.6 " 19.6	3.9 " 2.6	0	16.2 " 9.5	0	10.7 " 10.7
Total number of species	19	13	22	16	27	16	28	20	15	29	29

Table 3. Numbers of nests found, by study area, in 1998-2000, ordered by total number.

Species	Crookston			Glyndon			Sheyenne		Total			All
	1998	1999	2000	1998	1999	2000	1999	2000	1998	1999	2000	
Clay-colored Sparrow	20	86	27	71	119	93	56	66	91	261	186	538
Savannah Sparrow	41	150	141	21	25	25	27	44	62	202	210	474
Bobolink	23	27	24	25	20	18	9	22	48	56	64	168
Red-winged Blackbird	6	2	7	6	4	4	28	13	12	34	24	70
Western Meadowlark	1	6	2	3	1	2	25	17	4	32	21	57
Mallard	5	8	3	11	5	6	12	5	16	25	14	55
Le Conte's Sparrow	5	21	5	2	0	4	0	0	7	21	9	37
Brewer's Blackbird	12	8	9	4	3	0	0	0	16	11	9	36
Blue-winged Teal	0	0	0	3	1	4	17	10	3	18	14	35
Song Sparrow	2	2	0	5	8	10	3	0	7	13	10	30
Field Sparrow	0	0	0	0	0	0	13	16	0	13	16	29
Grasshopper Sparrow	0	0	1	3	4	0	8	8	3	12	9	24
Sedge Wren	0	10	6	3	3	1	0	0	3	13	7	23
Upland Sandpiper	0	1	6	7	3	2	3	1	7	7	9	23
Lark Sparrow	0	0	0	0	0	0	16	3	0	16	3	19
Vesper Sparrow	0	0	0	0	0	0	8	10	0	8	10	18
Mourning Dove	0	0	0	2	2	0	4	9	2	6	9	17
Eastern Kingbird	0	0	0	4	5	2	1	4	4	6	6	16
American Goldfinch	0	0	5	0	4	5	0	1	0	4	11	15
Greater Prairie-Chicken	2	1	3	2	2	2	0	0	4	3	5	12
Common Yellowthroat	0	0	0	2	4	3	0	1	2	4	4	10
Yellow Warbler	0	1	0	0	2	6	0	0	0	3	6	9
Common Snipe	2	3	0	1	1	0	1	1	3	5	1	9
Marbled Godwit	0	0	1	1	1	0	2	1	1	3	2	6
American Woodcock	0	1	0	0	1	0	0	4	0	2	4	6
Northern Harrier	0	2	1	0	1	1	0	0	0	3	2	5
Northern Shoveler	0	0	0	0	0	0	1	3	0	1	3	4
Gadwall	0	0	0	0	0	0	3	0	0	3	0	3
Wilson's Phalarope	0	0	0	0	0	0	2	1	0	2	1	3
Gray Catbird	0	1	0	0	0	2	0	0	0	1	2	3
Swamp Sparrow	0	1	0	0	1	1	0	0	0	2	1	3
Green-winged Teal	0	0	0	0	0	0	0	2	0	0	2	2
American Bittern	0	0	0	0	0	0	1	0	0	1	0	1
Redhead	0	0	0	0	0	1	0	0	0	0	1	1
Tree Swallow	0	0	0	0	0	1	0	0	0	0	1	1
Brown Thrasher	0	0	0	0	1	0	0	0	0	1	0	1
Marsh Wren	0	0	0	0	0	1	0	0	0	0	1	1
Chipping Sparrow	0	0	0	0	0	0	1	0	0	1	0	1
Yellow-headed Blackbird	0	0	0	0	0	0	0	1	0	0	1	1
Dickcissel	0	0	0	0	0	1	0	0	0	0	1	1
Total	119	331	241	176	221	195	241	243	295	793	679	1767

Table 4. Mayfield estimates of daily nest survival (May), its standard error (SE), percentage of nests parasitized by Brown-headed Cowbirds (Cow), and sample size (N) in small and large plots in neutral and hostile landscapes, by region, in 2000.

a) Crookston Region

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N
Savannah Sparrow	0.94 " 0.01	0	45	0.93 " 0.02	1	10	0.93 " 0.01	3	64	0.86 " 0.03	0	19
Clay-colored Sparrow	0.77" 0.08	0	8	0.95 " 0.03	0	6	0.87 " 0.05	20	5	0.94 " 0.04	0	6
Bobolink	0.70 " 0.12	0	4	-	0	1	0.87 " 0.03	0	13	0.85 " 0.07	0	5

b) Glyndon Region

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N
Savannah Sparrow	0.93 " 0.03	0	9	0.94 " 0.04	0	3	0.88 " 0.04	10	10	0.92 " 0.05	0	3
Clay-colored Sparrow	0.94 " 0.02	0	15	0.94 " 0.02	0	16	0.92 " 0.02	0	28	0.91 " 0.02	3.4	34
Bobolink	0.92 " 0.04	0	5	0.82 " 0.07	16.6	6	0.94 " 0.03	0	6	-	0	1

c) Sheyenne National Grassland

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N	May " SE	Cow	N
Savannah Sparrow	-	-	-	-	-	0	0.93 " 0.01	39.4	33	0.93 " 0.03	0	11
Clay-colored Sparrow	-	-	-	0.92" 0.02	3.6	36	-	-	0	0.91 " 0.02	19.2	26
Bobolink	-	-	-	0.89 " 0.05	0	4	0.98 " 0.02	0	10	0.80 " 0.06	0	8

Table 5. Causes of nest failure, by study region, in 2000.

	Crookston	Glyndon	Sheyenne
Depredated:	136	83	90
Egg-laying stage	7	0	1
Incubation stage	42	41	64
Nestling stage	37	42	25
Cowbird predation	0	0	18
Weather-related	10	7	0
Trampled	1	1	13
Unknown	0	1	3
Abandoned:	24	17	40
Partial predation	3	7	23
Partial cowbird predation	0	0	4
Cowbird parasitism	0	1	5
Unknown	21	9	8

Table 6. Percentage of grassland passerine nests that were parasitized by Brown-headed Cowbirds in 2000. Total numbers of nests are shown in parentheses.

	Crookston	Glyndon	Sheyenne	Total
Species	% (N)	% (N)	% (N)	% (N)
Red-winged Blackbird	14.3 (7)	0 (4)	23.1 (13)	16.7 (24)
Western Meadowlark	0 (2)	50.0 (2)	11.8 (17)	14.3 (21)
Brewer's Blackbird	11.1 (9)	-	-	11.1 (9)
Savannah Sparrow	2.3 (129)	4 (25)	29.5 (44)	8.6 (198)
Clay-colored Sparrow	4.8 (21)	1.1 (93)	9.7 (62)	4.5 (176)
Bobolink	0 (19)	5.6 (18)	0 (22)	1.7 (59)
Field Sparrow	-	-	0 (16)	0 (16)
Grasshopper Sparrow	0 (1)	-	0 (8)	0 (9)
Le Conte's Sparrow	0 (4)	0 (4)	-	0 (8)
Vesper Sparrow	-	-	0 (10)	0 (10)
Sedge Wren	0 (6)	0 (1)	-	0 (7)
Lark Sparrow	-	-	0 (3)	0 (3)
Dickcissel	-	0 (1)	-	0 (1)
Total	3.0 (198)	2.7 (147)	12.8 (187)	6.4 (531)